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(54) **NOTEBOOK COMPUTER HAVING HEAT PIPE**

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H05K 7/20 (2006.01)

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(58) **Field of Classification Search** ..... None
See application file for complete search history.

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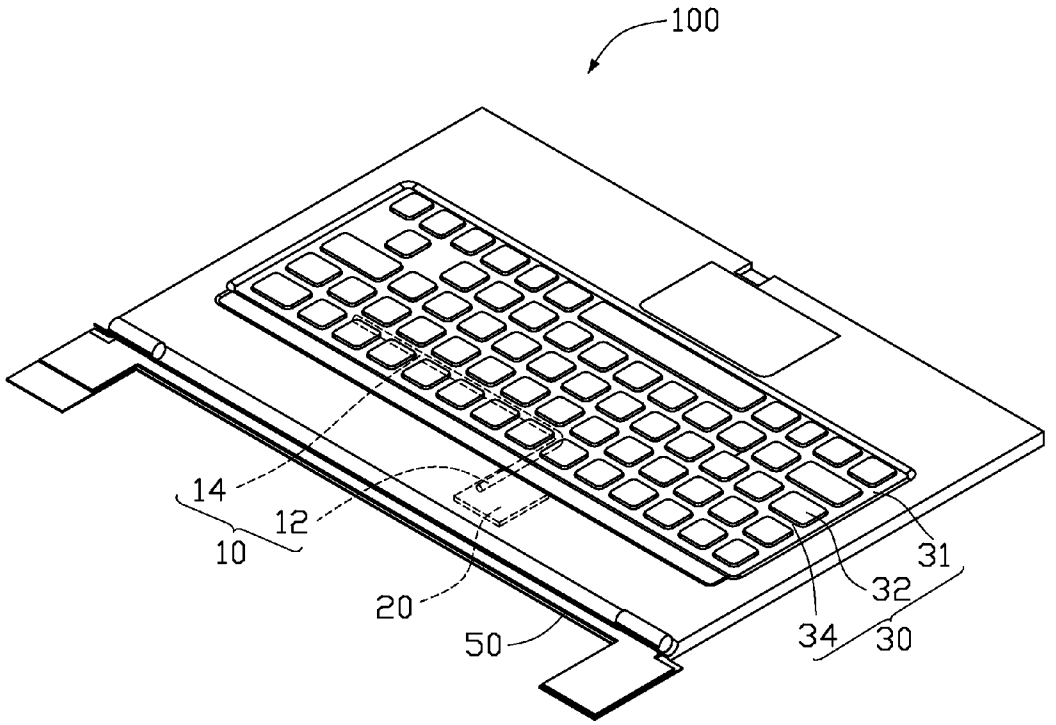
(57) **ABSTRACT**

A notebook computer includes a heat-generating component, a keyboard frame made of a heat conductive material and a heat pipe having an evaporator and a condenser. The evaporator of the heat pipe is in thermal communication with the heat-generating component and the condenser is attached to the keyboard frame and away from the heat-generating component.

8 Claims, 5 Drawing Sheets



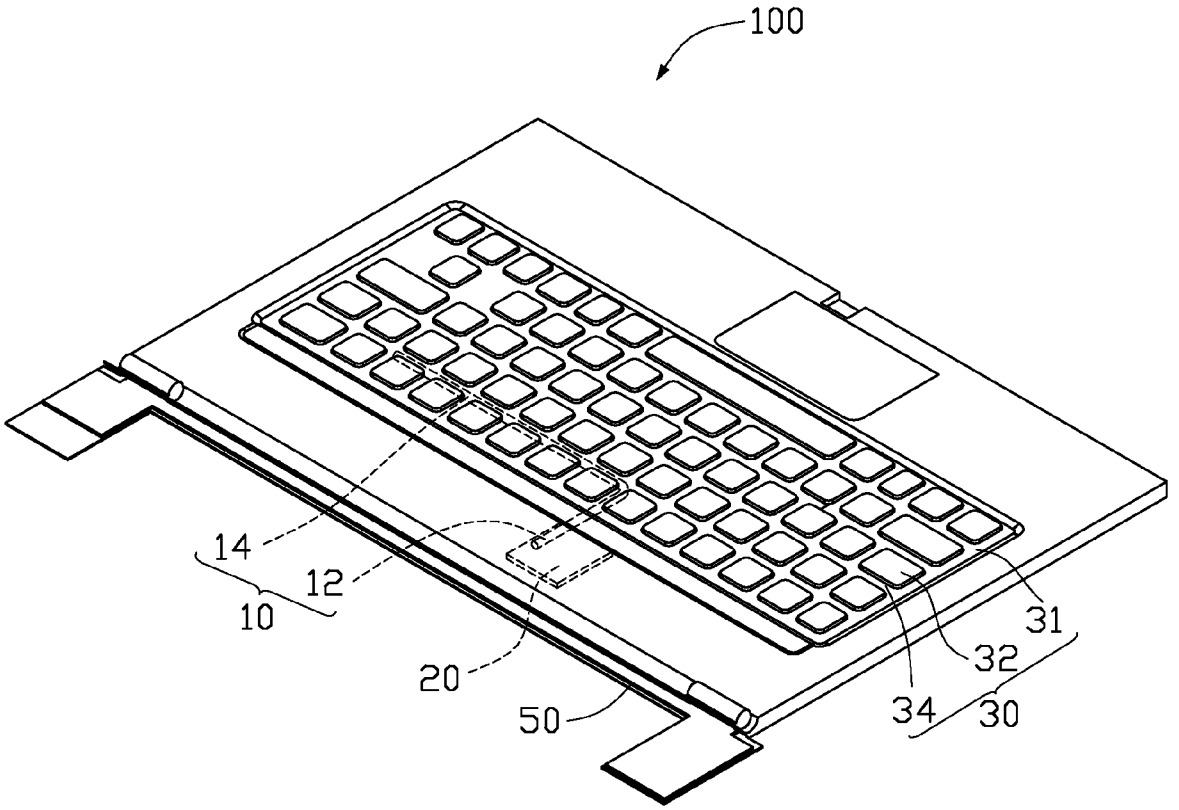


FIG. 1

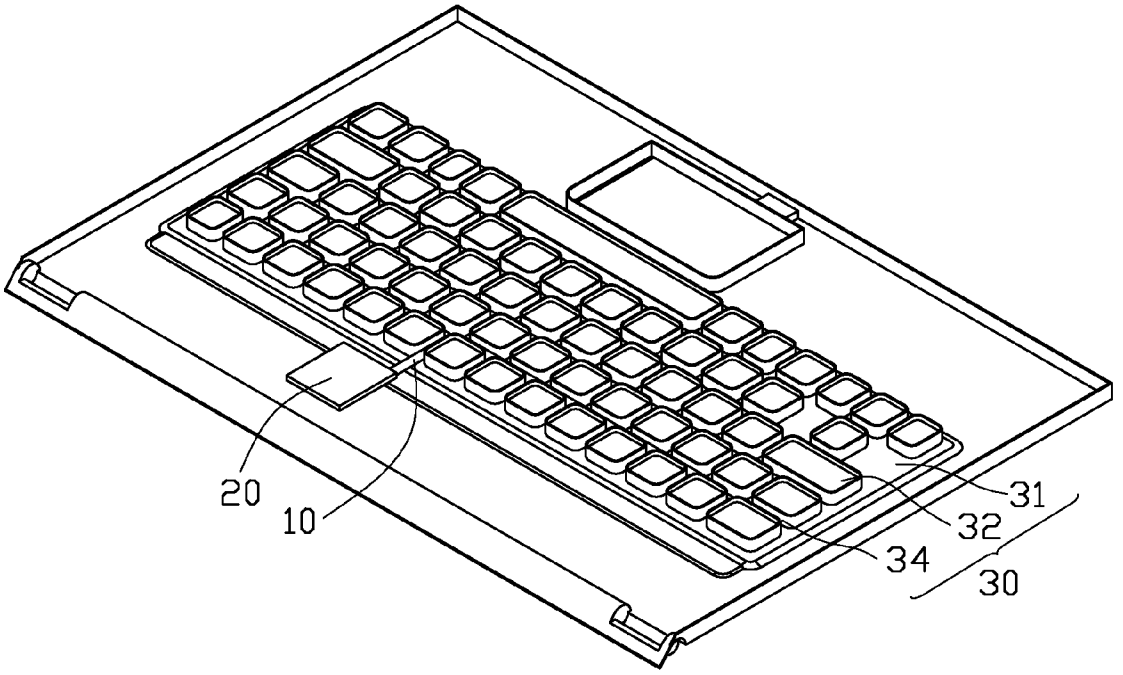


FIG. 2

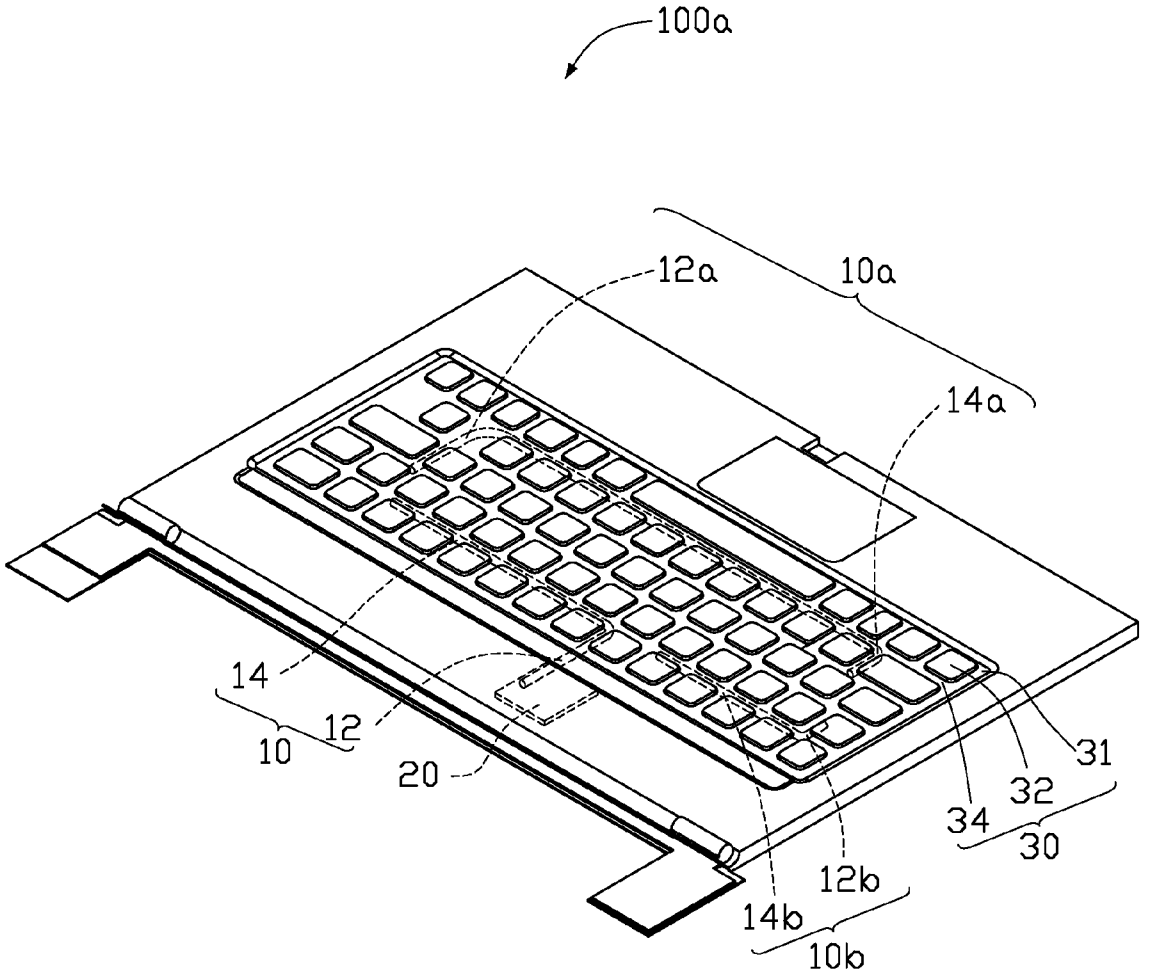


FIG. 3

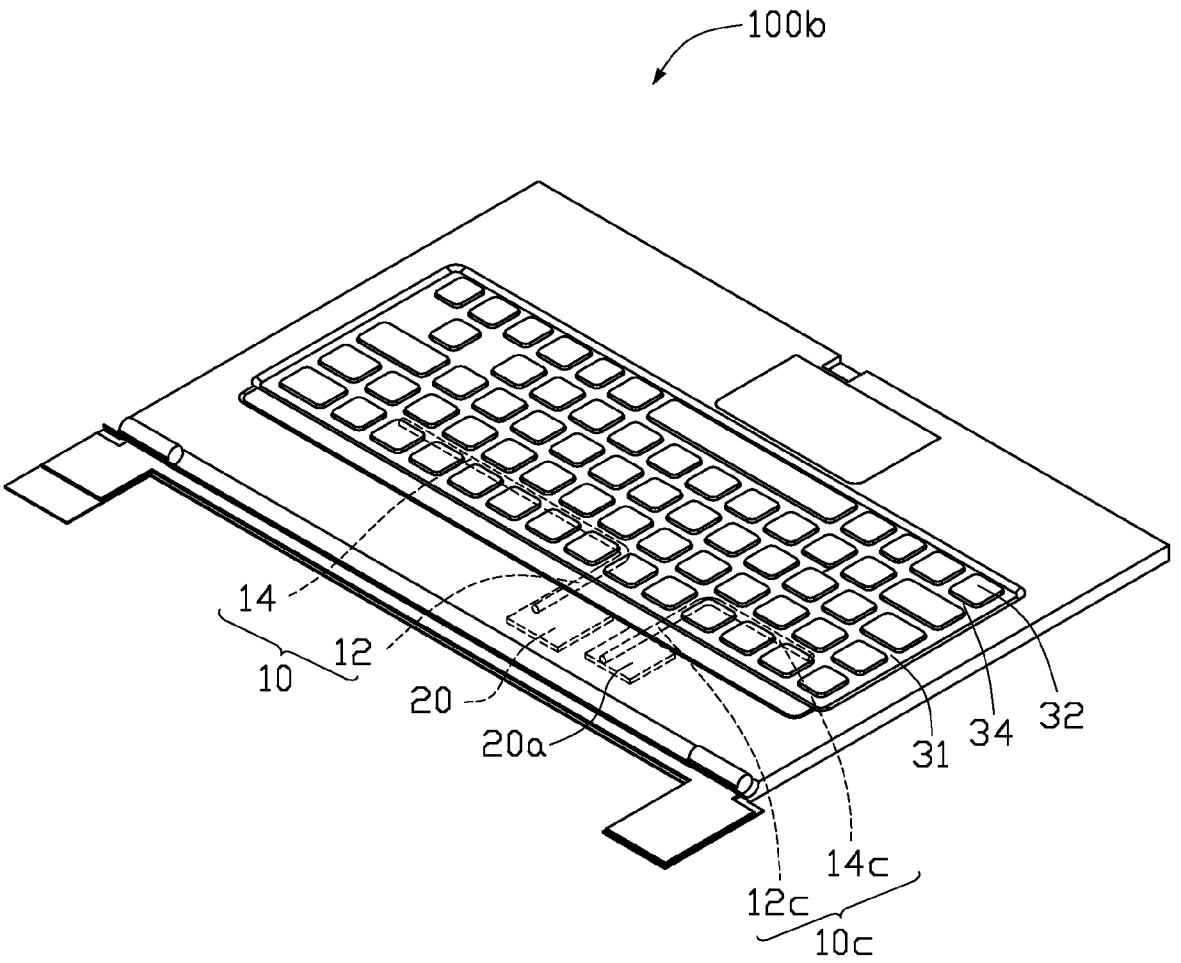


FIG. 4

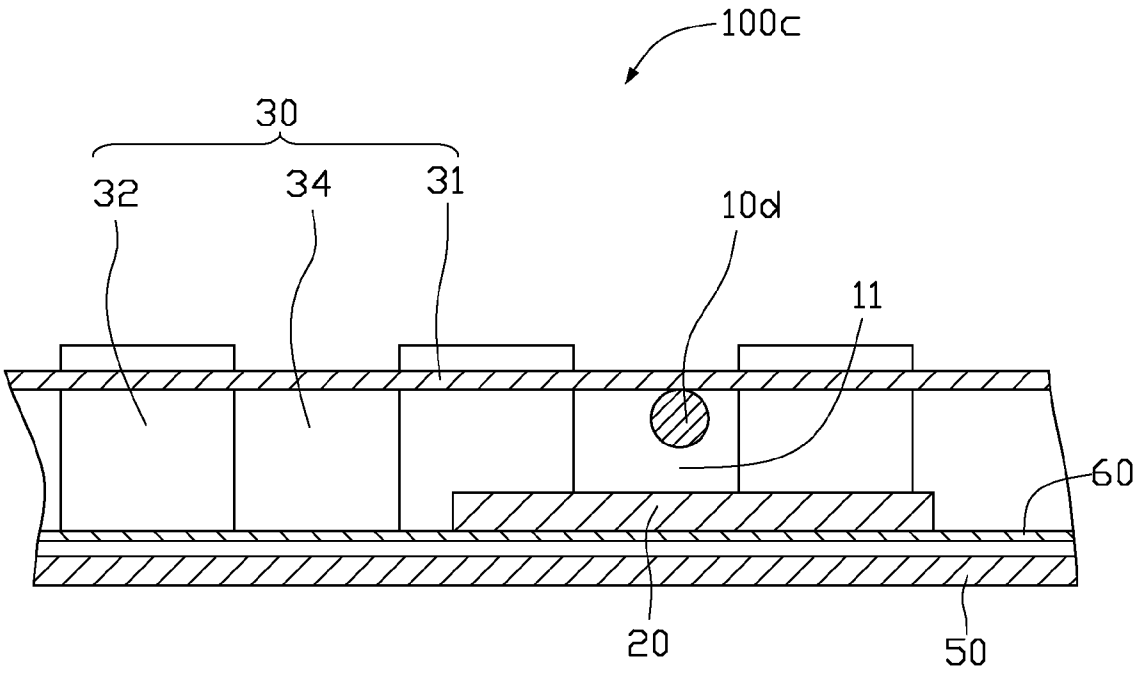


FIG. 5

NOTEBOOK COMPUTER HAVING HEAT PIPE

BACKGROUND

1. Technical Field

The present invention generally relates to a notebook computer, and more particularly to a notebook computer having a heat pipe coupled to a keyboard frame of the notebook computer for dissipating thermal energy within the notebook computer.

2. Description of Related Art

Successive new models of mobile computers, such as notebook computers, are continuing to shrink in size and become lighter, smaller and thinner. In addition, with the improvement of the functionality of the notebook computers, electrical power consumed by many of these notebook computers continues to increase. Thus, heat generated from microprocessors, disk drives, power supplies and other components of the notebook computers is often increased.

However, the notebook computers generally do not have heat dissipation devices having relative small size and high efficiency of heat dissipation. When the notebook computers operate for a relative long period of time, the notebook computers become very hot and tend to fail more often than cooler notebook computers.

Furthermore, since the notebook computers are continuing to shrink in size and become thinner, a distance between a heat-generating component within a notebook computer and a shell of the notebook computer becomes smaller and smaller, heat generated from the heat-generating component tends to heat up the shell, particularly a bottom wall of the shell around the heat-generating component, to a temperature beyond a safe threshold level. When the notebook computer becomes too hot, not only is it uncomfortable for the user, but concerns are expressed about possible safety and fire hazards.

SUMMARY

An exemplary embodiment of the present invention provides a notebook computer. The notebook computer includes a heat-generating component, a keyboard frame made of a heat conductive material and a heat pipe having an evaporator and a condenser. The evaporator of the heat pipe is in thermal communication with the heat-generating component and the condenser is attached to the keyboard frame and away from the heat-generating component.

Other advantages and novel features of the present invention will become more apparent from the following detailed description of embodiments when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an isometric view of a notebook computer in accordance with a first embodiment of the present invention.

FIG. **2** is an isometric view of the notebook computer of FIG. **1**, which is viewed from a bottom side with a bottom board of the notebook computer being removed away.

FIG. **3** is an isometric view of a notebook computer in accordance with a second embodiment of the present invention.

FIG. **4** is an isometric view of a notebook computer in accordance with a third embodiment of the present invention.

FIG. **5** is a side cross-section view of a notebook computer in accordance with a forth embodiment of the present invention.

DETAILED DESCRIPTION

Reference will now be made to the drawing figures to describe the embodiments in detail.

Referring to FIGS. **1-2**, a notebook computer **100** in accordance with a first embodiment of the present invention is illustrated. The notebook computer **100** comprises a bottom board **50**, a keyboard frame **30** covered on the bottom board **50** to form an enclosure, a heat-generating component **20** located within the enclosure, and a heat pipe **10**. In the embodiment, a display unit of the notebook computer **100** is not shown for the purpose of clarity. The heat pipe **10** thermally connects the heat-generating component **20** to the keyboard frame **30**.

The keyboard frame **30** includes a base **31** and a plurality of keys **32** arrayed in the base **31** in rows and columns. The base **31** is a rectangular and substantially planar board, which is made of a heat conductive material such as copper or aluminum. The keys **32** extend through the base **31** from a top surface to a bottom surface of the base **31**. A long and narrow channel **34** is defined between neighboring rows of keys **32** for installing the heat pipe **10**.

The heat pipe **10** is L-shaped and mounted on a bottom surface of the base **31** via soldering, adhering or other conventional methods. The heat pipe **10** has an evaporator **12** and a condenser **14** perpendicularly extending from the evaporator **12**. The evaporator **12** directly contacts with the heat-generating component **20** to absorb heat produced by the heat-generating component **20**. The condenser **14** extends in the channel **34** defined between neighboring rows of keys **32** to spread the heat absorbed by the evaporator **12** onto the whole base **31**. Then, the heat absorbed by the evaporator **12** is dissipated to ambient air through the larger surface of the base **31**. In other words, the heat pipe **10** and the base **31** together form a heat dissipation device for cooling the heat-generating component **20**.

As described above, the heat produced by the heat-generating component **20** can be quickly transferred away to the base **31** via phase transformation of working fluid contained in the heat pipe **10**. Therefore, the heat-generating component **20** can work within an acceptable temperature range. Since the heat pipe **10** has a high heat transfer performance with a small volume and the base **31** is substantially planar and thinner, the heat dissipation device formed by the heat pipe **10** and the base **31** has a small height and is suitable for dissipating thermal energy within the notebook computer **100** having a compact size.

Furthermore, since the heat produced by the heat-generating component **20** is transferred away to the base **31**, the heat-generating component **20** has a relative low temperature. Thus, the bottom board **50**, particularly the portion of the bottom board **50** around the heat-generating component **20**, has a relative low temperature, and the aforementioned problems in the conventional notebook computer are solved or at least mitigated.

Referring to FIG. **3**, a notebook computer **100***a* in accordance with a second embodiment of the present invention is illustrated. The difference between the notebook computer **100***a* and the notebook computer **100** is that the notebook computer **100***a* further comprises two heat-spreading heat pipes **10***a*, **10***b* (shown in dashed lines). The two heat-spreading heat pipes **10***a*, **10***b* are attached on the bottom surface of the base **31** and extend in the channels **34** between the neighboring rows of keys **32**.

The heat-spreading heat pipe **10***a* comprises a first end **12***a* arranged adjacent to the condenser **14** of the heat pipe **10**, and a second end **14***a* extending from the first end **12***a*. The

heat-spreading heat pipe **10***b* comprises a first end **12***b* arranged adjacent to the second end **14***a* of the heat-spreading heat pipe **10***a*, and a second end **14***b* extending toward the evaporator **12** of the heat pipe **10**. In other words, the heat pipe **10** and the two heat-spreading heat pipes **10***a*, **10***b* are arranged end-to-end to form substantially a loop. By such a design, the heat produced by the heat-generating component **20** is transferred to the base **31** via the heat pipe **10**, and then the heat is quickly spread at the whole base **31** via the two heat-spreading heat pipes **10***a*, **10***b*. This accelerates dissipation of the heat accumulated at the base **31**.

Referring to FIG. **4**, a notebook computer **100***b* in accordance with a third embodiment of the present invention is illustrated. The difference between the notebook computer **100***b* and the notebook computer **100** is that the notebook computer **100***b* further comprises another heat-generating component **20***a* (shown in dashed lines) and an another heat pipe **10***c* (shown in dashed lines). The another heat pipe **10***c* is L-shaped and attached to the bottom surface of the base **31**. The another heat pipe **10***c* comprises an evaporator **12***c* directly contacting with the another heat-generating component **20***a*, and a condenser **14***c* extending in the channel **34** defined between neighboring rows of keys **32**. Preferably, the condenser **14***c* extends in a direction opposite to that of the condenser **14** of the heat pipe **10** so that heat produced by the heat-generating component **20** and the another heat-generating component **20***a* is uniformly spread at the base **31**. This helps to make full use of the base **31** to dissipate heat.

Referring to FIG. **5**, a notebook computer **100***c* in accordance with a forth embodiment of the present invention is illustrated. The difference between the notebook computer **100***c* and the notebook computer **100** is that the notebook computer **100***c* further comprises an air-heating heat pipe **10***d*, which has an evaporator disposed above and does not contact with the heat-generating component **20** mounted on a printed circuit board **60**. A small distance **11** is defined between the evaporator of the air-heating heat pipe **10***d* and the heat-generating component **20**.

The air-heating heat pipe **10***d* further comprises a condenser (not shown) extending in the channel **34** in a manner similar to that of the condenser **14** as described above.

The heat pipe **10** of the first embodiment is not shown and only the different part, i.e., the air-heating heat pipe **10***d* is illustrated. The air-heating pipe **10***d* has a size smaller than that of the heat pipe **10** so that the evaporator **12** of the heat pipe **10** and the evaporator of the air-heating heat pipe **10***d* thermally connect with the heat-generating component **20** in different manners.

Since the distance **11** between the evaporator of the air-heating heat pipe **10***d* and the heat-generating component **20** is small, heat produced by the heat-generating component **20** heats up the air therebetween and the heated air conducts heat to the evaporator of the air-heating heat pipe **10***d*. In other words, the evaporator of the air-heating heat pipe **10***d* indirectly thermally contacts with the heat-generating component **20**. By the presence of the air-heating heat pipe **10***d*, the heat produced by the heat-generating component **20** is indirectly absorbed by the air-heating heat pipe **10***d*.

In addition, other heat-generating components within the notebook computer **100***c* also produce a lot of heat, which leads to an increase of the internal temperature of the notebook computer **100***c*. The air-heating heat pipe **10***d* can greatly reduce the internal temperature of the notebook computer **100***c*. Preferably, the air-heating heat pipe **10***d* can be designed to have an operating temperature range lower than that of the heat pipe **10**, which directly contacts with the heat-generating component **20**. In other words, the air-heating heat pipe **10***d* can be used to transfer heat by means of the phase transition of the working fluid therein under a temperature range lower than that of the heat pipe **10**. Thus, the internal temperature of the notebook computer **100***c* can be quickly and greatly reduced.

It is to be understood, however, that even though numerous characteristics and advantages of the present invention have been set forth in the foregoing description, together with details of the structure and function of the invention, the disclosure is illustrative only, and changes may be made in detail, especially in matters of shape, size, and arrangement of parts within the principles of the invention to the full extent indicated by the broad general meaning of the terms in which the appended claims are expressed.

What is claimed is:

1. A notebook computer comprising:
- a heat-generating component;
- a keyboard frame made of a heat conductive material and having a plurality of keys mounted thereon;
- a heat pipe having an evaporator and a condenser; and
- at least one heat-spreading heat pipe;
- wherein the evaporator is in thermal communication with the heat-generating component and the condenser is attached to the keyboard frame and away from the heat-generating component;
- wherein the evaporator directly contacts with the heat-generating component;
- wherein the keyboard frame includes a base and the plurality of keys is arrayed in the base in rows and columns, the keys extending through the base from a top surface to a bottom surface of the base with a plurality of long and narrow channels each being defined between two neighboring rows of the keys, the condenser being attached to the bottom surface of the base and extending in at least one of the channels; and
- wherein the at least one heat-spreading heat pipe is attached to the bottom surface of the base, the at least one heat-spreading heat pipe extending in the channels, the heat pipe and the at least one heat-spreading heat pipe together forming a loop.

2. The notebook computer of claim **1**, wherein the at least one heat-spreading heat pipe comprises two heat-spreading heat pipes, the heat pipe and the two heat-spreading heat pipes are arranged end-to-end to form a loop.

3. A notebook computer comprising:
- a heat-generating component;
- a keyboard frame having a plurality of keys mounted thereon; and
- a first heat pipe having an evaporator and a condenser extending from the evaporator; and
- a second heat pipe having an evaporator and a condenser extending from the evaporator of the second heat pipe;
- wherein the evaporator of the first heat pipe physically contacts with the heat-generating component and the evaporator of the second heat pipe is located near the heat-generating component and spaces a distance therefrom; and
- wherein at least one of the condensers of the first heat pipe and the second heat pipe is attached to the keyboard frame.

4. The notebook computer of claim **3**, wherein the second heat pipe has an operating temperature range lower than that of the first heat pipe.

5. The notebook computer of claim **4**, wherein the keyboard frame includes a base and the plurality of keys is arrayed in the base in rows and columns, the keys extending through the base from a top surface to a bottom surface of the

base with a plurality of long and narrow channels each defined between two neighboring rows of the keys, the at least one of the condensers of the first heat pipe and the second heat pipe being attached to the bottom surface of the base and extending in at least one of the channels.

6. A notebook computer comprising:

a heat-generating component;

a keyboard frame made of a heat conductive material and having a plurality of keys mounted thereon;

a heat pipe having an evaporator and a condenser; and

an air-heating heat pipe which absorbs heat from internal air within the notebook computer;

wherein the evaporator is in thermal communication with the heat-generating component and the condenser is attached to the keyboard frame and away from the heat-generating component;

wherein the evaporator directly contacts with the heat-generating component;

wherein the keyboard frame includes a base and the plurality of keys is arrayed in the base in rows and columns, the keys extending through the base from a top surface to a bottom surface of the base with a plurality of long and narrow channels each being defined between two neighboring rows of the keys, the condenser being attached to the bottom surface of the base and extending in at least one of the channels; and

wherein the air-heating heat pipe has an evaporator disposed above and close to the heat-generating component with a distance defined therebetween.

7. The notebook computer of claim **6**, wherein the air-heating heat pipe has a condenser extending in at least one of the channels.

8. The notebook computer of claim **6**, wherein the air-heating heat pipe has an operating temperature range lower than that of the heat pipe.

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